AS Computer Science – Unit 7 Arrays, tuples, records, queues Unit 8 Boolean Algebra- Gates/simplification

Name: Block: Mark: /70 Grade:

Part 1 – Unit 7 – Data Structures (Arrays, Tuples and Records and Queues) **Mark: /35 Grade:**

Answer all questions.

1) Data structures may be described as static or dynamic.

a) State the meaning of the term static in relation to data structures. [1]

b) State one data structure that is always considered static. [1]

c) State the meaning of the term dynamic. [1]

d) Give one disadvantage of using a dynamic data structure. [1]

e) Give the name of one data structure that is dynamic [1]

2) A hospital has asked for a program that will control the order in which the arrivals are seen in the accident and emergency department.

(a) A priority queue has been chosen to store the arrival information.

(i) State the property of a priority queue that makes it suitable for this application. [1]

(ii) The priority queue is implemented using a circular queue.

State an advantage of a circular queue which makes it more efficient in use of memory. [1]

(b) A test version of the priority circular queue consists of 5 cells. Arrival information consists of a severity rating and a last name. The severity scale is 3 (least severe), 2 (moderately severe), and 1 (most severe). For example, Mr Jones has a severity rating of 2. His arrival record would be '2 Jones'.

Complete the diagram to show the results after the following operations. [4]

Note: The first element in the queue has an index of 0.

	arrivals								
	[0]	[1]	[2]	[3]	[4]	count	front	rear	returned
	1 Black	1 Singh	2 Jones	3 Reeve		4	0	3	
Dequeue									
Enqueue '3 Mason'									
Enqueue '2 Ing'									
Dequeue									

3) A program stores a queue of mathematical questions to be asked to a user. The questions are asked in the order they are added. Once a question has been asked it cannot be asked again. New questions are continually added to the end of the queue.
The program will use a non-circular queue, questions, (implemented using an array) to store the questions.
The pointer, head, stores the index of the first element in the queue.
The pointer, tail, stores the index of the last element in the queue.

Fig. 3.1 shows an example of the data in the queue. head is currently 0, tail is currently 4.

"2*3"	"1+4"	"3–1"	"10/2"	"3+6"			

Figure 3.1

(i) Show the contents of the queue shown in Fig. 3.1, after the following code is run.

add("6+1")

[2]

((i i) State the values stored in head and tail after the code in part (i) has run.

head _____

tail _____

[2]

b). Complete the following algorithm, to ask the user to input a new question and then either add it to the queue, or report that the queue is full.

```
procedure add()
maxElements = 10
```

```
Endprocedure
```

[4]

(c). Describe why a queue is a suitable structure for this program. [2]

(d). Complete the following algorithm, to remove, and output, the first element in the queue.

```
procedure remove()
```

```
Endprocedure
```

[4]

7a) A teacher uses a program to store an array of 20 pupils pupil[0:19] she would like to sort them into two groups for a group activity. Write a pseudocode algorithm that will read the 20 names and then output lists consisting of every other pupil.

Example:

GROUP 1	GROUP 2
pupil1 pupil3 pupil5	pupil2 pupil4 pupil6

[5]

7b) In the array names[], where names[r,c] refers to the data at row r and column c:

Names[]	0	1	2	3	4	5
0	Alan	Kuldeep	Li	Sarah	Harry	Mary
1	Jane	Tomasz	Charles	Thomas	Jane	Irina
2	Wendy	Deborah	Dillip	Umar	Johan	Hua

(i) What is stored in the variable names[1,4]? _____ [1]

(ii) Show what happens to the array when names[1,3] is set to Joe and names[1,1] is set to Navdeep. [2]

(iii) After these changes have been made, what is the output by the following program? [2]

```
For x = 1 to 3
    Print(names[1,x])
Next x
```

Part 2 – Unit 8 Boolean Algebra – Logic Gates, Truth tables, Simplification Mark /35 Grade:

1 (a) Complete the truth tables for the following logic gates.

AND gate		
Input X	Input Y	Output Q
0	0	
0	1	
1	0	
1	1	

XOR gate		
Input X	Input Y	Output Q
0	0	
0	1	
1	0	
1	1	

[2]

(b) Draw the logic circuit representing the expression

$A \veebar B \wedge A \veebar C$ [3]

(c) What is the output if A = 0, B = 1 and C = 1? ____ [1]

(d) Represent the Boolean equation $Q = \neg(A \wedge \neg (B \wedge C))$ in the form of a logic circuit.

[3]

(e) Show, by completing the truth table below, that Q = ¬(A ∧ ¬ (B ∧ C))

is equivalent to X = ¬A ∨ (B ∧ C)

1	2	3	4	5	6	7	8	9
A	B	C	B ∧ C	¬(B ∧ C)	¬A	¬Q	Q	X
0	0	0						
0	0	1						
0	1	0						
0	1	1						
1	0	0						
1	0	1						
1	1	0						
1	1	1						

[4]

2. (a) What is the name commonly associated with the statement

¬(A ∨ B) = ¬A ∧ ¬B [1]

(b) Simplify the following Boolean expressions. Show each stage of your working.

(i) (¬A ∨ ¬B) ∧ B [2]

(ii) A ∧ B ∧ (¬C ∨ A) ∧ ¬C [2]

(iii) ¬(A ∧ B) ∧ (¬A ∨ B) ∧ (B ∨¬ B) [5]

3. The light at a pedestrian crossing turns green if the button has been pressed and EITHER there are no vehicles approaching, OR the timer exceeds one minute. These conditions are expressed in the following table.

B = 1	Button pressed
V = 1	Vehicle approaching
T = 1	Timer exceeds 1 minute
G = 1	Light turns green

Draw the logic circuit for this scenario. [2]

4. (a) Complete the Karnaugh map below to represent the following expression:

$(\neg A \wedge \neg B \wedge \neg C \wedge \neg D) \vee (\neg A \wedge \neg B \wedge C \wedge \neg D) \vee (A \wedge \neg B \wedge \neg C \wedge \neg D)$

$\vee (A \wedge B \wedge C \wedge D)$ [4]

(b) Draw the resulting groups. [3]

(c) Hence simplify the expression. [3]

END OF PAPER